

Technology Opportunity

Advanced Metallics

The National Aeronautics and Space Administration (NASA) seeks to provide direct contributions and technologies for materials development to satisfy short-, mid-, and long-range goals.

Potential Commercial Uses

Copper-chromium-niobium alloys

- Welding electrodes
- Brazing fixtures
- High temperature heat exchangers
- Electrical contactors
- Molds for plastics and metal castings

Nickel aluminide

- Die cast molds
- Glass making molds
- Electronic/superconducting substrates
- Diesel engine inserts/preburner chambers
- Incinerator liners
- High temperature heat exchangers
- High temperature/oxidation resistant coatings

Hot turbine engine components such as

- Combustion liners
- Disks
- Nozzles
- Blades

Organic/inorganic material characterization

- Metallics
- Ceramics
- Minerals
- Paint chips

Benefits

Copper-chromium-niobium alloys

- Longer life of parts
- Less downtime on production lines
- Improved designs
- Improved quality
- Improved dependability

Nickel aluminide

- High thermal conductivity
- Excellent thermal stability
- Outstanding oxidation resistance
- High melting point
- Lower density than other Nickel or Iron-base alloys
- Can be made extremely creep resistant

Other

- Fully synergistic R&D system that allows materials to be fully described/developed in one place
- Significant experience/expertise in all subdisciplines ensures exhaustive and accurate results
- Improved material life/durability in application
- Improved consistency in material behavior
- Designs may be modified as a result of improved material behavior to reflect the better retention of properties over the life of the part

The Technology

Materials can be procured or processed by appropriate methods that allow them to be accurately analyzed for specific goals. Depending on what is required, materials may be characterized on the basis of physical, mechanical, and/or microstructural properties. In many cases, the materials must be further developed in order to be used in an identified application. Areas of expertise include, but are not limited to, Ni-base alloys, copper alloys, metal-matrix composites, intermetallics, and refractory metals. The research and development (R&D) of these metallic materials is supported by a state-of-the-art mixture of expertise and facilities for such core competencies as processing, extensive mechanical testing, metallography, electron microscopy, microprobe, x-ray diffraction, and chemical analysis.

The Cu-Cr-Nb alloys form a fine, uniformly dispersed second phase, Cr_2Nb , in an essentially pure copper matrix. The Cr_2Nb is not only extremely stable up to the melting point of copper but also is



very hard and strengthens the copper. The best properties are achieved in the temperature range of 482 to 816 °C. Here the alloy's strength is twice that of most other competitive copper-based alloys. The ductility of the alloy is good, with elongations being greater than 15 percent and reductions in area being greater than 25 percent for all samples tested. And strength degradation due to exposure to elevated temperatures for up to 100 hr was minimal, even at temperatures above 816 °C. The creep lives of Cu-Cr-Nb alloys are as much as 100 to 1000 times longer than those of competitive alloys. Thermal and electrical conductivities of the alloys range from 72 to 96 percent of the conductivity of pure copper. Thermal expansions are lower than for pure copper, and this can lead to lower thermally induced stresses. Exposure to high pressure hydrogen has been shown not to degrade the mechanical properties.

Nickel aluminide (NiAl) is a B2-ordered intermetallic compound that exhibits a wide range of physical and mechanical characteristics that would be suitable for applications ranging from hardware for the hot sections of gas turbine engines to buried interconnections in electronic components. For example, NiAl has a density of 5.9 g/cm³, which is approximately two-thirds that of typical Ni-base superalloys. It has a high thermal conductivity, which helps reduce thermal fatigue and hot spots during high-temperature use, has a relatively high melting point (1638 °C), and exhibits a high degree of structural stability. The outstanding oxidation resistance of NiAl-based materials is well known and has been exploited for many years in the form of coatings for Ni-base superalloys. The material can also be made in extremely creep resistant forms by single crystal processing and by cryomilling (a process developed by NASA Lewis to produce an aluminum nitride dispersion-strengthened alloy that can be handled by conventional powder metallurgical routes). Additional information on NiAl can be found in NASA TM-105598 and NASA TP-3398.

Options for Commercialization

The Materials Division at NASA Lewis is willing to assist industry, academia, and the community by providing expert R&D assistance for problems relating to material improvement. If your company is interested in learning how materials R&D may benefit you, please contact us.

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Key Words

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